

TR-406 Determine Initial Cause for Current Premature Portland Cement Concrete Pavement Deterioration

Key Words

Premature Concrete Deterioration
Entrained-Air Void System
Ettringite
Concrete Durability
Premature Stiffening
PCC

ABSTRACT

A detailed investigation has been conducted on core samples taken from 17 portland cement concrete pavements located in Iowa. The goal of the investigation was to help to clarify the root cause of the premature deterioration problem that has become evident since the early 1990's. Laboratory experiments were also conducted to evaluate how cement composition, mixing time, and admixtures could have influenced the occurrence of premature deterioration. The cements used in this study were selected in an attempt to cover the main compositional parameters pertinent to the construction industry in Iowa.

The hardened air content determinations conducted during this study indicated that the pavements that exhibited premature deterioration often contained poor to marginal entrained-air void systems. In addition, petrographic studies indicated that sometimes the entrained-air void system had been marginal after mixing and placement of slab, while in other instances a marginal to adequate entrained-air system had been filled with ettringite. The filing was most probably accelerated because of shrinkage cracking at the surface of the concrete pavements. The results of this study suggest that the durability - more specifically, the frost resistance - of the concrete pavements should be less than anticipated during the design stage of the pavements.

Construction practices played a significant role in the premature deterioration problem. The pavements that exhibited premature distress also exhibited features that suggest poor mixing and poor control of aggregate grading. Segregation was very common in the cores extracted from the pavements that exhibited premature distress. This suggests that the vibrators on the paver were used to overcome a workability problem. Entrained-air voids formed in concrete mixtures experiencing these type of problems normally tend to be extremely coarse, and hence they can easily be lost during the paving process. This tends to leave the pavement with a low air content and a poor distribution of air voids. All of these features were consistent with a premature stiffening problem that drastically influenced the ability of the contractor to place the concrete mixture. Laboratory studies conducted during this project indicated that most premature stiffening problems can be directly attributed to the portland cement used on the project. The admixtures (class C fly ash and water reducer) tended to have only a minor influence on the premature stiffening problem when they were used at the dosage rates described in this study.